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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/825,875	04/03/2001	Sarath D. Gunapala	06816/035003/CIT 2426-C-C	4598

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EXAMINER

KANG, DONGHEE

ART UNIT	PAPER NUMBER
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2811

DATE MAILED: 07/31/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/825,875

Applicant(s)

GUNAPALA ET AL.

Examiner

Donghee Kang

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 22 May 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 2-89 is/are pending in the application.
- 4a) Of the above claim(s) 2-40, 68-70 and 84-89 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 41-67 and 71-83 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 03 April 2001 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 5.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Information Disclosure Statement

1. Acknowledgment is made of receipt of applicant's Information Disclosure Statement (PTO-1449) filed April 3, 2001.

Election/Restrictions

2. Applicant's election without traverse of Group 2 (claims 41-67 & 71-83) in Paper No. 7 is acknowledged.

Specification

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. The specification is objected to as failing to provide proper antecedent basis for the claimed subject matter. See 37 CFR 1.75(d)(1) and MPEP § 608.01(o). Correction of the following is required:

Antecedent basis for the claimed subject matter in claims 71 & 72, lines 8 & 2, respectively is required, namely:

the "a *barrier layer of a first semiconductor material that is greater than 300 microns in widths*" and "*said barrier layer is greater than 500 microns in width*", which are not disclosed in the description section of the specification.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

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(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims **41-44 & 46** are rejected under 35 U.S.C. 103(a) as being unpatentable over Behtea et al. (US 4,894,526).

Regarding claims **41-42**, Bethea teaches a device, comprising (Fig.1b &2):

a plurality of quantum elements, each with a well layer having a well bottom, a well top, and bound energy states within said well layer, said well layers being formed of materials that cause a bound energy state to be close to said well top, at a level that allows an electron in said well to escape to an electron continuum area of higher energy state electron, by tunneling through the thin top of the barrier (see also Col.3, line 4 – Col.5, line 53). Levine does not explicitly teach photocurrent tunneling through less than 50 angstroms of top of barrier. However, it is a known scientific fact that the number of particles, which will tunnel through a barrier is inversely proportional to the thickness of that barrier. Thus, it would have been obvious in the art at the time the invention was made to modify Bethea's device to select a depth of well region such that photocurrent tunnels less than 50 angstroms. Such modification would provide Bethea's device with more quantum efficiency so as to obtain a high signal because particle can easily tunnel through barrier layer.

Regarding claim **43**, Bethea teaches the device further comprising an element that adjust a direction of input radiation, relative to said quantum well elements (see Col.5, lines 17-21).

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Regarding claim **44**, Bethea teaches the device further comprising a electrical contact layers (2 & 4), including a first electrical contact layer (2) on a first side of said quantum well elements, and a second electrical contact layer (4) on a second side of said quantum well elements.

Regarding claim **46**, Bethea teaches the device can be made to form arrays as may be suitable for imaging applications (see Col.3, lines 17-18).

7. Claim **45** is rejected under 35 U.S.C. 103(a) as being unpatentable over Bethea (US 4,804,526) in view of Bethea et al. (US 5,023,685).

Bethea ('526) does not teach the element that adjust direction of input radiation is formed as part of one of said electrical contact layers. However, Bethea ('685) teaches roughened surface can be used for coupling (see Fig.6 & Col.4, lines 15-21). Thus, it would have been obvious in the art at the time the invention was made to incorporate the teaching of Bethea ('685) into Bethea's device ("526"), since IR light inside the detector structure can be obtained by incorporating a randomly roughened reflecting surface on top of the detectors. The random structure on top of the detector prevents the light from being diffracted normally backward after the second bounce as happens in the case of cross-grating.

8. Claims **47-55** are rejected under 35 U.S.C. 103(a) as being unpatentable over Bethea in view of Kozlowski (Electron Device, Vol.38 (5), May 1991).

Bethea applies to claim **41** as explained above.

Regarding claims **47-48, 51-53, & 56**, Bethea does not explicitly teach the plurality of quantum well elements are arranged into a plurality of quantum well stacks, each quantum well stack including a plurality of periods, each period comprising a well layer and first and second barrier layers, and each quantum well stacks associated with one of said image sensor. However, Kozlowski teaches forming hybrid focal plane array by mating the silicon CMOS readouts to the GaAs detector array via indium interconnects (see also Fig.10 & part III. 128 x 128 CMOS Readout on page 1127). Thus, it would have been obvious in the art at the time the invention was made to fabricate hybrid FPA by mating the silicon CMOS readouts to the GaAs detector array, since QWIP FPA provides a better performance compared with other FPA technologies.

Regarding claims **49-50 & 77-78**, Bethea does not teach a plurality of bumps, connecting between said quantum well stacks and said image sensor, wherein said image sensors are CMOS image sensors. However, Kozlowski teaches in Fig.10 indium bump is formed between detector array and Si readout circuit. Thus, it would have been obvious in the art at the time the invention was made to form indium bump in order to provide an interconnection between detector array and Si readout circuit.

Regarding claims **54, 57, & 73**, Bethea as modified by Kozlowski teaches image sensors has a peak sensitivity in the infrared region.

Regarding claim **55**, Bethea as modified by Kozlowski the well layer is formed of GaAs.

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Regarding claims **58 & 79**, Bethea as modified by Kozlowski teaches radiation direction adjusting element that adjusts a direction of input radiation relative to said quantum well stacks.

Regarding claim **61**, Bethea as modified by Kozlowski teaches a plurality of electrical contacts, associated with said semiconductor.

Regarding claims **64 & 76**, Bethea as modified by Kozlowski teaches there are 50 of said quantum well structure in each of said quantum well stacks.

Regarding claims **65 & 83**, Bethea as modified by Kozlowski teaches the well layers are formed of GaAs and the barrier layers are formed of AlGaAs.

Regarding claims **66 & 75**, neither Bethea nor Kozlowski teaches said image sensors have a peak reception at 8.5 micron. However, it is well known in the art that the peak reception can be changed by appropriate adjustment of the well width and the barrier height. Therefore, it would have been obvious in the art at the time the invention was made to select of the well width and the barrier height in order to obtain 8.5 micron peak.

Regarding claim **67**, neither Bethea nor Kozlowski teaches said quantum well is formed of $\text{Al}_y\text{Ga}_{1-y}\text{As}$ and said barrier layer is formed of $\text{Al}_z\text{Ga}_{1-z}\text{As}$. It is a known scientific fact that the well's height depends on the band gap of the $\text{Al}_x\text{Ga}_{1-x}\text{As}$ layer and relative portions of Al and Ga ("x") in the $\text{Al}_x\text{Ga}_{1-x}\text{As}$ layer. Thus, it would have been obvious in the art at the time the invention was made to change the portion of Al and Ga in order to provide a quantum well region which captures photons generated by the incoming radiation.

Regarding claims **71-72 & 74**, Bethea as modified by Kozlowski teaches substantially the entire claimed invention except that a barrier layer is greater than 300 Å in width. However, it is a known scientific fact that the number of particles, which will tunnel through a barrier is inversely proportional to the thickness of that barrier. Therefore, it would have been obvious in the art at the time the invention was made to form more than 300 Å width of barrier layer in order to prohibit a sequential resonant tunneling which causes a dark current.

9. Claims **59-60, 62-63, & 80-82** are rejected under 35 U.S.C. 103(a) as being unpatentable over Bethea (4,894,526) in view of Kozlowski, as applied to claims 56 & 71 above, and further in view of Bethea et al. (US 5,023,685).

Regarding claims **59, 62-63, & 80**, neither Bethea ('526) nor Kozlowski teaches a device further comprising a plurality of random reflectors. However, Bethea ('685) teaches forming random reflectors (61) to adjust directing of radiation. Thus, it would have been obvious in the art at the time the invention was made to incorporate the teaching of Bethea ('685) into Bethea's device ("526"), since IR light inside the detector structure can be obtained by incorporating a randomly roughened reflecting surface on top of the detectors. The random structure on top of the detector prevents the light from being diffracted normally backward after the second bounce as happens in the case of cross-grating.

Regarding claims **60 & 81-82**, none of prior art teaches the random reflectors are formed of gold or silver. However, it would have been obvious to one having ordinary

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skill in the art at the time the invention was made to form the random reflectors, *having the materials as claimed*, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 125 USPQ 416.

Conclusion

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

C.G.Bethea et al. (IEEE electron device, Vol.40 (11), November 1993)

C.G.Bethea et al. (IEEE electron device, Vol.38 (5), May 1991)

B.F.Levine et al. (Appl. Phys. Lett., 50 (16), 20 April 1987)

Nagai (JP 403032071 A).

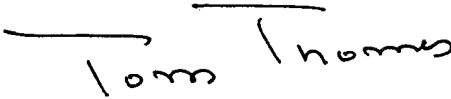
11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Donghee Kang whose telephone number is 703-305-9147. The examiner can normally be reached on Monday through Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on 703-308-2772. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

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Donghee Kang, Ph.D.
July 26, 2002


TOM THOMAS
SUPERVISORY PATENT EXAMINER
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